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EVALUATION OF A SPATIAL DATA MANAGEMENT SYSTEM
FOR BASIC SKILLS EDUCATION: PHASE 1

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) As part of the Army's continuing effort to deal with the basic skill deficits of some soldiers, the Human Resources Research Organization (HumRRO) has been evaluating the Spatial Data Management System (SDMS) as a tool for basic skills education. The SDMS is a computer-based videodisc system with an easy-to-use information location and accession software package. A key focus of HumRRO's effort has been to identify ...continued on back		

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20. Abstract (Continued)

- the special design requirements for creating interactive videodisc educational materials.

Certain elements were found to be essential in developing successful interactive videodisc educational materials. These include the need to focus on the highly motivational characteristics of video and the need to devote much attention to the content and sequence of feedbacks to student responses. Also important is the need for a well-organized design process to account for the highly integrated nature of all aspects of the process—design, scripting, production, post-production and programming.

This report is a case study of the project's first phase, with emphasis on the instructional design issues involved.

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In 1980 HumRRO was awarded a contract to evaluate the Spatial Data Management System as a tool for basic skills education. The sponsors of the contract are the Army Research Institute for the Behavioral and Social Sciences, The Defense Advanced Research Projects Agency and The Adjutant General's Office. Each of these agencies is working both to improve the basic skills of Army recruits and to apply the latest in advanced technologies to enhance performance throughout the Army. Figure 1 is a visual overview of the scope of the project.

THE SYSTEM

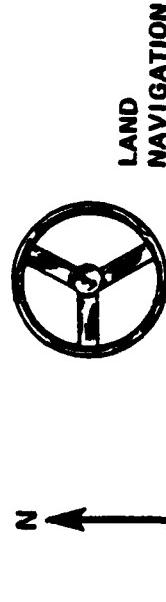
Spatial data management is a concept which was developed by the Architecture Machine Group at the Massachusetts Institute of Technology. The Spatial Data Management System (SDMS) allows a user to access information by selecting an icon or text descriptor which represents the available information. These icons and text descriptors are arranged on a "data plane," a two-dimensional virtual space, in some spatially logical order. A user may browse through a data plane by moving a cursor with a joystick or other pointing device. To access the information associated with a given icon, the user simply places the cursor at or near the icon and then presses a function button. The information thus accessed may be video and/or audio segments from a videodisc, text from a computer file or a new data plane with its own array of spatially organized icons.

MIT's experimental version of the SDMS is described as a multiple media information place, or a "media room" (Bolt, 1979). One wall of the media room

EVALUATION

RESEARCH AND DEVELOPMENT

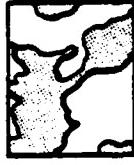
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ORIENTATION



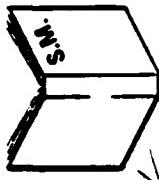
NEEDS FOR
BASIC SKILLS



LAND
NAVIGATION



LEARNING
STRATEGIES



STUDY
SKILLS

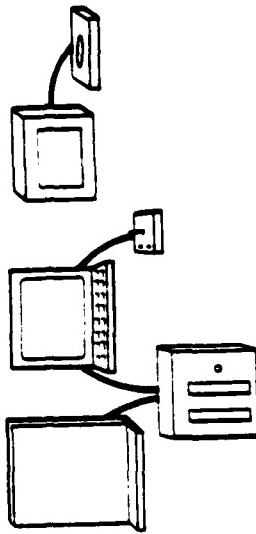


TEST
TAKING



ANXIETY
REDUCTION

MOS BASELINE
SKILLS



READING



LISTENING



COMPUTATION

TECHNOLOGY
TRANSFER
RECOMMENDATIONS
FOR ARMY-WIDE USE



Figure 1: Project Overview of the Evaluation of the Spatial Data Management System

is dedicated to a large display screen and eight speakers provide sound output. A special Eames chair is placed directly in front of the display screen. Each arm of the chair has a pressure-sensitive joystick and a touch sensitive pad. A data tablet with a stylus serves as a lap pad and a small microphone allows voice input. On each side of the chair is a touch-sensitive television monitor. The media room is one image of an office of the future where the user is directly engaged with data in a variety of forms.

Figure 2 is an example of how instructional material on spatial orientation might be organized on a series of interconnected data planes. Students simply press a button, "ZOOM IN", to enter a lesson or move to another data plane, and "ZOOM OUT" to exit a lesson or return to a higher level data plane. Our experience with research subjects indicates that users pick up quickly on how to find and access the information they are interested in.

The original MIT version of the SDMS has spawned several, less costly, variants, including the one used in our project. This system is composed of off-the-shelf equipment packaged for us by Interactive Television Company (Levin, 1980). The components of the system include a Z-80 based micro computer, a Pioneer industrial videodisc player, a color monitor, a monochrome monitor and a control box with a joystick and eight buttons. A keyboard is also included for authoring purposes. Figures 3 and 4 show students using this verion of SDMS.

Interactive Television Company has developed a software package, SDMS, that allows users to have the spatial data management capabilities described above, with the data stored and accessed from a variety of media--videodisc, microfiche, and computer text files. At HumRRO we use the SDMS to present the lesson options available to the students.

Figure 2: Simplified Version of Spatial Orientation Skills Dataland

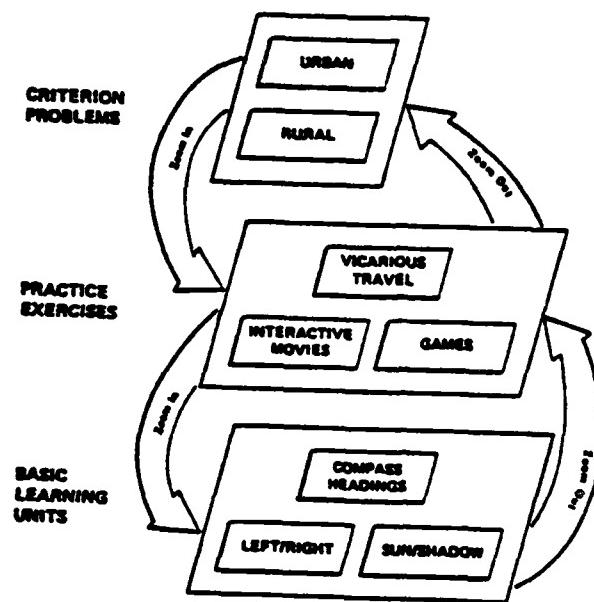




Figure 3

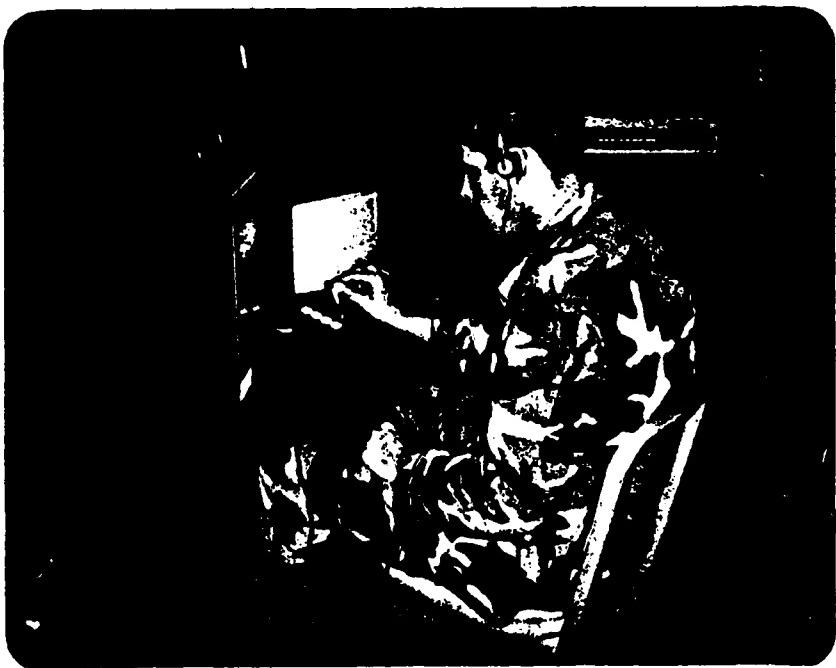


Figure 4

BSEP II Students Using SDMS in Field Test at Fort Stewart, Georgia.

Along with the SDMS is another software package called the Interactive Movie System or IMS. The IMS allows a programmer or lesson author to create a computer program which controls the flow of the instruction. We refer to such a computer program as a "network" because it allows us to specify what information is displayed to the student and how that information is linked to other parts of the lesson. As its name implies the IMS allows us to write programs or networks so that our students can interact with moving images. The images, stored on a videodisc, can be accessed as movies or still frame slides. We can control their rate of presentation and the number and type of choices available to the student during the presentation. The IMS also allows us to use the two sound tracks and specify computer text and graphics for presentation to students. We found it especially valuable that the IMS was easy to learn to use. Networks could be created by writers and instructional designers and we were not required to hire professional programmers to perform this function. In summary, the IMS allows us to use efficiently all the features of the random access videodisc player and supplement the learning environment with some of the desirable features of computer-based learning, such as scorekeeping, counting student errors, using variable values to branch students to other material, and recording data about student performance.

SDMS AS AN INSTRUCTIONAL DELIVERY SYSTEM

A number of elements of the SDMS/IMS make it a potentially valuable tool for instruction, and particularly basic skills education. The ease with which information can be accessed negates the need for typing skills or a knowledge of computer languages. The motivational nature of video, enhanced by the interactive nature of this system, provide the opportunity to maximize user

interest and involvement. This is particularly important with a target population whose prior experiences with school or training have not, by and large, been good ones.

In order to evaluate the SDMS as an instructional delivery system, videodiscs had to be created. A series of 12 discs were produced, which can be grouped into 4 major categories: prototype (2), study skills and test taking (4), spatial orientation and navigation skills (3), and learning strategies (3). In the discussion which follows we will describe the instructional material on these videodiscs, how it was developed, and how it takes advantage of the special features of the SDMS. Our primary focus, however, is on how this material was designed to meet the special needs of our target audience.

OUR APPROACH

Objectives and subject matter are, of course, key considerations when selecting a presentation format for instructional material. Yet, equally critical to us were the characteristics of our target audience. They have been selected to participate in a special remedial program, the Basic Skills Education Program (BSEP). The reading level of these students varies, but is generally below grade nine. Even more important, they have never had many successful experiences in learning situations. All in all their motivation to learn is not high. We looked to previous research for advice beyond our own intuition and experience in how to motivate these young soldiers. We found guidance in the research literature in two major areas: instructional television (Rust, 1973; Lesser, 1974) and computer games (Malone, 1981). Some of these guiding concepts are described in the following sections.

Instructional Television Research

In 1973, Dr. Langbourne Rust, formerly associated with formative research for Sesame Street and now of Langbourne Rust Research in Briarcliff, New York, was asked to identify attention gaining attributes for junior and senior high school students. Since these initial studies he has been able to expand his work to adults.

The research was directed toward finding the most effective program design techniques to attract and hold attention. The idea was that if you can identify what type of scenes or program elements get the most attention in everyday commercial programming, you can design instructional programs to include those attributes. Rust used the distractor technique in which a group of viewers watch either a TV program or a changing slide display while a camera recorded their eye movements. After a large number of programs were viewed, graphs were produced with attention scores for each scene or segment. Those scenes getting the highest and lowest scores were analyzed, and the results were a list of attention gaining and attention losing attributes. Briefly stated, some of the attention-getting attributes are:

Functional Action: Scenes that portray locomotion or active movement through space which is directly functional to the development of the plot or theme of the scene in question.

Action Imperatives: Scenes in which someone tells someone else what to do (either another character or the audience).

This I How I Feel: Scenes in which an individual directly expresses how he personally feels about something or what he thinks about it.

Bridge of Understanding: Scenes containing something that the individual viewer can strongly identify with.

On-Screen Correction of Incorrect Performance: Character(s) correcting their own or another's inappropriate actions.

Repeated Trials or Successive Attempts: Characters trying repeatedly to accomplish a goal or task.

Scenes which consistently get low attention scores contain the following:

Abstract Informal Monologues: Scenes in which a character tells someone or the audience about general, abstract, or objective truths.

Opening and Closing Scenes: Credits, titles and other standard beginnings and endings that are unrelated to the story.

Comprehensible Spoken Script: A spoken soundtrack without reference to the screen.

Later in 1973 an instructional program was designed and produced using the attributes identified. When this program was tested, it not surprisingly showed a higher average attention score than any of the other programs

tested. High attention does not necessarily mean increased learning, but it does not invalidate the usefulness of these findings. Quoting Rust: "The picture they do give is a powerful and pervasive one . . . producers of these instructional films will do well to avoid the low-attention qualities whenever possible and to tell their stories or convey their information using functional action, action imperatives, or the forthright expression of how individuals feel". (p.119)

Computer Games Research

"What Makes Things Fun to Learn?: A Study of Intrinsically Motivating Computer Games" by Thomas Malone was published in 1980 by the Xerox Palo Alto Research Center. Malone first identified three characteristics of computer programs which make them so captivating; then explored each in depth to prescribe various approaches that instructional computer game designers can take to use them. These three characteristics are:

- Challenge and Goal Orientation: To establish and maintain interest in the game a clear goal should exist, one which is challenging but attainable.
- Fantasies: Intrinsic fantasies promote and sustain involvement, although the appeal of a given fantasy will, in part, be a function of individual taste.
- Curiosity: Interest will be created and maintained to the extent that the learner must continue with the game in order to complete his knowledge about it.

Malone also warns that the following can be detrimental to learning:

Negative Challenge Characteristics: Excessively challenging activities that discourage the individual can lower a person's self-esteem, resulting in decreased interest in the instructional activity.

Negative Fantasy Characteristics: "In some cases, however, giving a fantasy a great deal of mundane realism (e.g., a flight simulator for pilots) may detract from wish fulfillment or other emotional advantages of fantasy." (p. 59)

Malone hypothesized from his research that these characteristics could be used to make learning with computers both interesting and enjoyable. Like Rust, he, too, is interested in a prescriptive approach. Where Rust works in the areas of attention, Malone is interested in motivation. As Malone says, "If students are intrinsically motivated to learn something, they are likely to spend more time and effort learning, feel better about what they learn, and be more likely to use it in the future."

We sensed the beginnings of a powerful approach to designing instructional videodiscs. Part television, part computer game, interactive videodisc should be able to use prescriptions from both areas of research to provide a very special learning environment. But still remaining was the question: Will the program structure guided by these prescriptions help students learn and retain the content of the instruction, or will it attract attention to itself and not the information?

HOW WE ACCOMPLISHED OUR GOALS

The Development Process

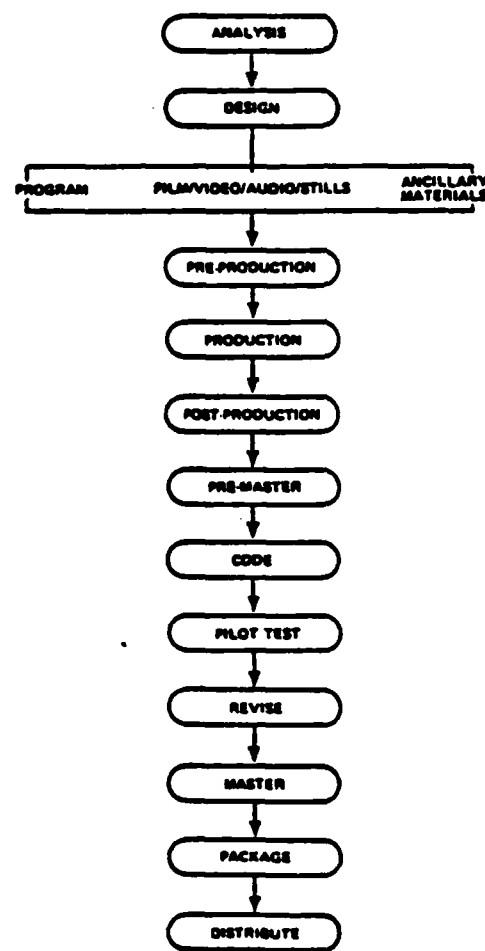
Although our primary mission in this project is research and evaluation of the SDMS, a good portion of the project effort has been spent on developing the interactive videodisc-based lessons. As is the case with all instructional development projects at HumRRO, our development process is based on the systematic approach known as Instructional Systems Development (ISD).

ISD is a multi-step process in which an instructional developer first analyzes the task or job for which the instruction is to be provided. Training objectives are then developed to meet the identified needs and criterion referenced tests are designed to determine if the training objectives are being met. The instructional strategies and sequence are then defined prior to the development of individual lessons. Evaluation, both formative and summative, is a key feature of the ISD process. Lessons are revised based on the findings of a pilot or field test before being released for operational use (Butler, 1972).

For our videodisc work, we have modified and refined the steps somewhat, while adhering to the ISD principles. Figure 5 is a flowchart which gives an overview of the development sequence we use in our development of interactive videodiscs. More specifically, the steps we follow are:

1. Performing an analysis of the instructional needs of our target audience in regard to the specific content area.
2. Formulating a plan for the research study that will be conducted.

Figure 5: Interactive Videodisc Development Sequence



3. Developing/refining the objectives for all the lessons.
4. Brainstorming how to help students meet these objectives.
5. Writing up prose descriptions (on a unit description form) of plans for the lessons.
6. Having the initial plans approved by the sponsor.
7. Revising and expanding the prose descriptions into "treatments".
8. Developing first draft scripts, control structures for computer programming and interaction, and storyboards (if needed).
9. Getting formal reviews of subject matter experts, sponsors, etc.
10. Developing final shooting script for all visual material.
11. Producing/gathering of all visuals.
12. Editing and assembling the material.
13. Transferring material to 1-inch videotape.
14. Mastering the videodiscs.
15. Programming the student interaction.

16. Pilot testing.
17. Revising the computer programs based on pilot test results.

Management

Project management was based on a team approach. For each set of video-discs in a related content area, a team was formed to develop and produce the instructional materials. Project managers were responsible for coordinating the efforts of the various teams. Team members fill the following roles: research scientist, subject matter expert, team manager, instructional designer, writer, computer-based learning expert, and television producer. In many cases one person would perform several of these functions. Thus, a team usually consisted of four to six people. While most of the video and film production was contracted out, programming of the interaction was done by HumRRO staff.

All of the teams spent a healthy proportion of their budgets and time on the design and planning steps. With well-laid plans and carefully developed scripts, we were able to avoid costly re-shoots of video and film material. In addition, the early months of the project were spent exploring the new possibilities of computer-controlled interactive video. We learned, for example, the importance of educating cameramen and video and film editors about the nature of interactive video. The next section describes our approach to our first effort, the prototype discs.

PROTOTYPE MATERIAL

The overall objective of the two prototype videodiscs was to demonstrate the flexibility of the SDMS as an instructional tool, both in terms of the content of the instruction provided and the method of presentation. In addition, the prototype discs were viewed as an opportunity to experiment with various videodisc production techniques and modes of student interaction. A wide variety of ideas were considered for inclusion, and prose descriptions were developed for each. These descriptions included the projected length of the segment, its learning objectives and a general description of the instructional content, dramatic presentation and interactive segments.

When all of the unit descriptions were completed, they were reviewed internally. A group of units was selected which was judged to most be creative in regard to the presentation of the content, and which demonstrated the greatest variety of methods of presentation. An attempt was made to select at least one unit from each major content area. An example of this material is the game Angle Pool.¹

An Instructional Game

One of the highly interactive pieces developed for the prototype was a game called Angle Pool. The objective of this piece was to give the user practice in judging commonly referenced angles (0, 15, 30, 45, 60, 90, 135, and 180 degrees). Estimating angles is a skill required in a number of military tasks, such as reading a compass and measuring elevations in

¹For a description of all the materials on the prototype and other videodiscs, see Seidel, R.J. & Wagner, H. Evaluation of a Spatial Data Management System for Basic Skills Education. HumRRO Interim Report IR-PRD-83-21, January 1983.

artillery firing. Given the deficiencies in basic math skills of many recruits, there appeared to be a need for this type of instruction.

The primary challenge faced in the design phase was that of maintaining student interest in the practice session while ensuring that a high level of proficiency was achieved before the lesson was completed. It was felt that the more the student could be "brought into" the lesson the greater the motivation and interest would be. With this in mind, a pool game was created.

The next few pages show some of the forms that we used to design, develop and produce Angle Pool. Figure 6 is a flowchart of the game. In the Appendix are the unit description and several pages of the forms we used to specify computer control and student interaction.

In the game a young enlisted man playing pool is encountered by the viewer. He challenges the viewer to a special game, Angle Pool, in which players must guess the correct angle (from 0°) at which the ball must travel if it is to fall into a designated pocket. The angle is displayed by showing an overhead shot of the pool table. The choices and a scoreboard are displayed on the black and white monitor.

When a student is correct, the feedback consists of the ball being shot into the pocket and the pool player complimenting the student. Each exercise is formatted in such a way that the correct feedback (sinking the ball) is a continuation of the motion made in setting up the problem. As the player lines up the shot, action freezes and the choices come up on the control screen. When the correct angle is chosen, the shot simply continues, with no jump or searching on the disc. It was felt that this format would heighten the feeling on the part of the student that the action of the ball going into the pocket was a direct result of the action of pressing a button. It was

* NUMBERS CORRESPOND TO
SEQUENCE NUMBERS

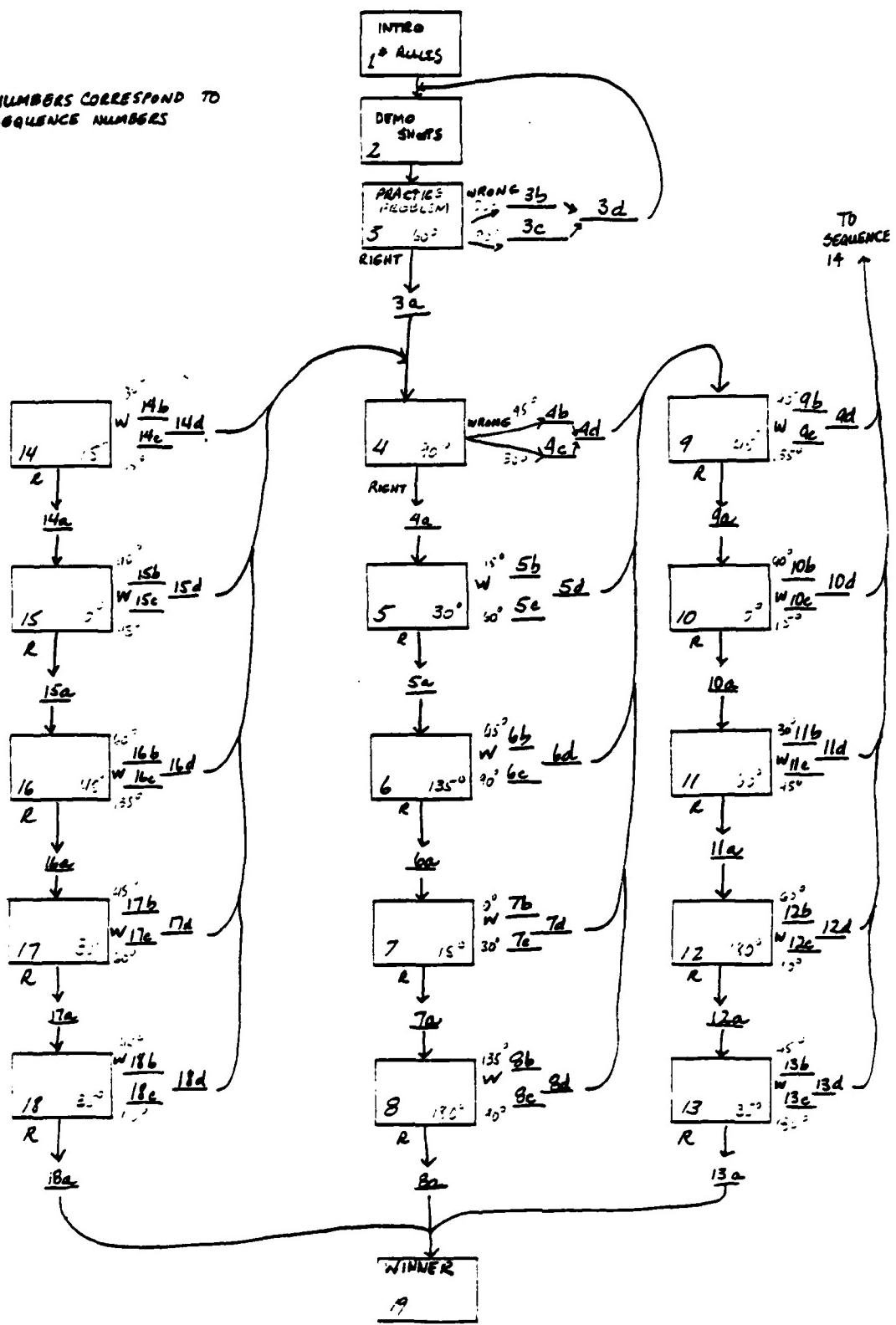


Figure 6: Flowchart of Angle Pool

assumed that this would serve to increase the intrinsic fantasy of the game and would therefore play an important part in maintaining motivation.

If the student makes a wrong selection, he is shown both the consequence of the mistake (the ball is shot at the angle chosen, missing the pocket), and the correct angle with the ball going into the pocket. The verbal feedback from the pool player for an incorrect choice is friendly and non-threatening, as he encourages the student to keep trying.

In designing the game, we hypothesized that, if the game was short, those who knew the content would not mind playing. In fact, the brief mastery experience would help build confidence. However, for those who needed the instruction and experience in judging basic angles, brief contact would not be meaningful. Playing the same game over and over, and receiving the same "canned" feedback responses would soon become frustrating, causing the student who needs the instruction most to lose interest. To prevent this, we created many problem situations with unique feedback for each possible answer. The goal was to estimate five angles in a row (correctly). After the fifth angle is correctly chosen, the lesson finishes with a victory handshake, a backslap and a challenge to two other players.

The combination of direct interaction with the character on the screen and the immediate and individualized feedback serves to attract the student's interest. By varying the problems and focusing on the goal of getting five in a row correct, this interest is maintained until the goal is reached. At this point the student's knowledge of these basic angles, and, more importantly perhaps, confidence in this knowledge, should be high.

TEST TAKING SKILLS

For many recruits entering the army, particularly those enrolled in BSEP, functioning successfully in an academic environment has been a continual problem. Many of these same recruits are not fully aware of the extent to which test taking skills will be important in their army careers. Virtually every military occupational speciality (MOS) requires that skill qualification test (SQTs) be administered. In many MOSs these tests can affect salary and grade/rank.

The typical SQT has three components: a written multiple choice test, a hands-on test in which the soldier must physically demonstrate ability to perform the various tasks associated with his/her MOS, and a job site component, where performance is evaluated as the soldier actually does his/her job. Overall performance on the hands-on and job site components is usually quite good. However, some 90% of the soldiers Army-wide fail the written portion of their SQTs.

This poor performance on the written SQT is the result of a combination of factors. Although much has been written about the skills involved in studying, it has not been standard procedure to teach these skills in any systematic way in primary or secondary schools. As a result many individuals have developed ineffective study habits, which leave them inadequately prepared for tests. Furthermore, in a testing situation such students are often unaware of the various strategies which might help them in their performance. Continued unsuccessful performance on tests will likely lead to a negative attitude about them. In fact, a presumption that one will do poorly, often becomes a self-fulfilling prophecy. In addition, feelings of tension are sometimes associated with the testing situation. In some cases this tension

can severely impair the student's performance. It is estimated that some 20% of college students suffer from such test anxiety. One can only guess about the incidence of test anxiety among BSEP participants, but it is likely to be higher than the college population rather than lower.

In an effort to confront these various problems which contribute to the high rate of SQT failure, four videodiscs were developed. Two of these focus on means for combatting test anxiety--positive self-talk and relaxation techniques. The other two deal with study skills and test-taking tips. Our overall approach to this videodisc-based content was to provide dramatic scenes that would entice the viewer to practice with and learn from someone who demonstrates or models correct behaviors and responses.

TEST ANXIETY

There are two stages in combatting test anxiety. The first stage involves recognizing what test anxiety is, understanding how it affects performance, and realizing that it can be mastered. On each disc, this first stage was approached by a fifteen-minute non-interactive presentation which smoothly integrated three formats. Segments from a continuing dramatic film in which soldiers struggle against and finally learn to defeat the two types of anxiety are interspersed with instructional segments describing test anxiety and brief testimonials by real soldiers telling how this type of anxiety affects them. The dramas show young soldiers facing examinations which could affect their military careers. The soldiers (actors) describe how they feel as they approach the testing situation and during the examination itself. The brief testimonials help the students identify with the problem even further, and are placed directly adjacent to the appropriate dramatic segment. They

consist of "This is how I feel" statements by soldiers from a variety of ethnic backgrounds. The instructional segments reinforce the drama and testimonials by describing why the soldiers feel the way they do, as well as offering immediate solutions.

The interactive materials which follow the fifteen minute linear presentations suggest that the students follow specific step-by-step techniques that can be used to combat their problem. The dramas were purposefully filmed to remind the students of their fears and rekindle some of the anxieties that testing situations bring. During the interactive sections, it is suggested that the students start learning to reduce their own anxiety by practicing certain techniques while viewing scenes from the dramas that instill anxiety. In other sections, students are asked to practice along with a model. This technique has been used successfully in therapeutic environments, and we felt it would be easily adapted to videodisc. The students are talked through each step of the techniques, then given a chance to practice on their own. While no modeled scene can instill the same level of anxiety that a real testing situation brings, a very strong effect was produced through the combination of contemporary tension-producing film devices and the use of situations, characters, and settings that the students identify as part of their day-to-day world.

We have found that the use of models and strong storylines to help students identify with problems and to motivate them to learn is an effective means of teaching affective subjects. Moreover, the effectiveness of this method has been enhanced by interactive videodisc through the use of second audio tracks, audio without video and rapid access to review material.

STUDY SKILLS

The major difficulty associated with the development of the study skills module was that of finding/developing the procedure to recommend, and motivating the student to use the procedure outlined. During the research phase in which members of the development team actually followed the steps a soldier would have to go through in order to prepare for an SQT, a number of factors became apparent. The most important of these was the need to emphasize the steps involved in locating the information which should to be studied. This can be a complicated process, given the variety of manuals and notices which may be required. In addition, after consulting with a variety of professionals involved in SQT development and administration, the decision was made to recommend a simple straightforward study procedure, rather than the more complex approaches taken by those dealing with college students. The degree to which the techniques recommended appeared to be overly involved or time consuming would greatly influence the likelihood that the student would actually employ them. In other words, a balance had to be found between an overly simple (and therefore more attractive) study procedure which would most likely be less effective, and a more complex, multi-faceted procedure which, although effective, would scare the student off.

The procedure recommended is presented to the student in a step-by-step manner. As each step is explained, a soldier (the model) is seen actually carrying out the step. In order to increase student involvement, the computer is programmed so that after a particular step is explained, the student is presented the option of reviewing that step, reviewing all of the steps covered to that point, or continuing. In addition, the steps in the procedure

are summarized on the black and white monitor. It is hoped that these measures circumvent the problems inherent in a long presentation containing a dense amount of information.

Exercises which required students to use off-line materials (a "work-book") were also incorporated into the unit. Throughout the design process an attempt was made to make each piece as self-contained as possible. In this case, however, it was impossible to provide realistic practice without including some off-line materials. We felt it was necessary to develop exercises which would require students to work with the actual manuals they would use when studying for their SQTs. The workbook contains modified pages from Army manuals. The student learns the material on these pages by using the recommended study procedure. Students then compare their work with example images stored on the videodisc.

Pilot students who used the study skills material generally indicated that they found it useful, and more important, something no one had previously taught them. At the present time research is being conducted, the goal of which is to assess the impact the materials have on soldiers' SQT scores.

SPATIAL ORIENTATION AND NAVIGATION SKILLS

A series of three discs were developed to provide instruction in basic spatial orientation and navigation skills. The first disc contains an overview of the package and a series of exercises or "tests" used primarily for research purposes. The second disc focuses on three learning strategies: imagery, partitioning and selective attention. Each of these pieces begins

with a presentation describing the strategy and how it can be used, followed by exercises which give the student an opportunity to employ the strategy in learning navigational information.

The third disc contains the most interactive and diverse material produced thus far. The major part of the disc is devoted to a series of exercises and games. To work through this material the student must have a firm grasp on concepts such as sun and shadows and cardinal directions. In addition, a number of the exercises require memory skills, such as those presented on the first disc. The remainder of the disc is devoted to six brief instructional presentations. These segments contain information on the basic navigational facts needed in the exercises. They may be presented first, and/or serve as remediation when the student makes a mistake during the exercises.

The development of the navigational exercises was greatly influenced by research on video instruction and games, in particular the work of Malone (1980). As discussed earlier, Malone identified three characteristics of computer games which make them so captivating, and prescribed various approaches instructional designers can take in using them. The three characteristics cited are:

- Challenge and goal orientation
- Fantasy
- Curiosity

The piece most directly influenced by Malone's research was one created to help soldiers learn the proper way to read military grid maps. Locating positions on a map using grid coordinates is a relatively simple task once the method is learned. However, there are two areas where the soldier who does not regularly deal with military maps can get confused. First, the first half of the grid location "82349783" is the latitude of the location, the second half (-9783) represents the longitude. A reversal results in a misreading of the position. Second, the final two numbers in each half of the coordinate are interpolations between printed grid lines. Judging such small intervals accurately takes practice even when using map reading aids.

After viewing an instructional film, students are presented an exercise to help build proficiency in reading coordinates. The exercise was designed to be a fast-paced game. A series of still frames present numbered grids, each with a marked location and four possible grid coordinate choices. If the student chooses the correct answer, a feedback frame is presented and an appropriate computer-generated sound effect is heard. Then a still frame giving the accumulated score is shown. The goal is to get five correct answers in a row. The sooner that goal is reached, the higher the score.

The student can select one of three games (or "fantasies"), but problem sequences are identical. "Tank Wars" involves the simulated destruction of an enemy tank located at the grid coordinates. Computer-generated battle sounds accompany the game. In "To Catch a Thief" the fantasy involves locating and jailing a thief before cash is stolen. The sound of a jail door closing accompanies this fantasy. A neutral fantasy involving locating an "X" on the grid map is the final scenario.

To make the game increasingly challenging and to help teach the basic concept of coordinates, the first round is played with only two digit answer possibilities. Later rounds increase the number of digits until a total of eight digits is reached. Consistently poor performance will result in students being automatically referred to a segment of the instructional film which reminds them of the rule, "Read Right, Then Up." When the student is able to identify five eight-digit coordinate locations, he/she begins a series of rounds with decreasing amounts of time available for answering. This "mastery" phase of the instructional game has proven to be the most popular.

The grid coordinate game is highly dependent on a computer program to control the flow of the game. After the brief presentation of game rules, there are simply 3750 still frames on the disc. The game, fairly simple albeit tedious to produce on film, was not so simple to program. Personnel time to program and debug these games was the equivalent of several person months.

In general, the research on using these games as instructional tools proved that, no matter the fantasy, students were learning to read grid maps. Use of the videodisc system and gaming approach created an interesting environment where students were successful. Our hypothesis is that this success is based partially on the fact that while playing the game the student was actually over-practicing the skill. We hope over-practicing will also help students retain this knowledge.

A more elaborate game was created to help students follow directions to geographical locations. A special software feature of the SDMS, called vicarious travel, was used to allow the student to control a mission simulated by a character on the screen. Vicarious travel is a technique wherein film in

a moving film camera is shot frame-by-frame. For example, to simulate driving still frames are photographed every ten feet, compressing the time (and disc space) that is required to view travel through a geographic area. The film is later transferred to videodisc and when it is programmed can give the illusion of real-time movement, even though playback is at approximately seven frames per second rather than the normal thirty. The joystick on the SDMS is used to control movement forward and backwards and to increase or decrease speed. When a decision must be made to go either left or right, a movement of the joystick to the corresponding side permits motion in that direction. The choices available to the student at any time by movement of the joystick are programmed to be carried out almost instantaneously.

Two humorous adventure exercises (again "fantasies") were created in which a character searches for a kidnapped friend in rural and urban settings. The goal is to help the character locate the missing friend by following directions given on a series of notes in vicarious travel mode. After making five or six decisions, a new direction set is obtained and the search continued. Each new set is presented in a brief slapstick segment presented at normal speed. After the note is read aloud by the character, the new directions come up on the computer monitor so that the students may refer to them as they travel. When the students successfully complete the game, they view a comedy sketch involving the reunion of the two friends.

The intrinsic fantasy of directly causing the character to move, slow down, and change directions by moving the joystick is the most obvious motivational characteristic. Because the computer authoring system is so flexible in manipulating the order of the vicarious travel segments, direction receiving segments, and feedback remediation, there are a number of ways of

increasing the challenge of the game. Other parameters, such as numbers of mistakes allowed, can also be changed to maintain interest. One of our goals is to identify what level of challenge motivates rather than frustrates students, and whether self-selection of degrees of difficulty is in itself a motivating force in the context of this game.

An assumption made in this game and in other instructional units is that entertaining video presentations, aside from their role as part of a game, will be seen as rewarding in themselves. In other interactive segments we have used the desire for the continuation of an enjoyable comic presentation as an important motivating force. In these cases, answering a question correctly will continue the presentation, while answering incorrectly interrupts the enjoyable presentation and requires the student to view remediation and answer the question again before continuing. In the example discussed above, the brief comic sketches serve as subgoals toward the final goal of locating the missing friend, as well as points where new sets of directions are received. These pieces have been found to be among the most popular as rated by research subjects.

In other exercises students must memorize the route a car takes across a map and direct a second car to follow the same route. Route memorization is also a key element in a series of exercises in which the student is given a set of directions which he/she must memorize in a set period of time. Then he/she must follow those directions using vicarious travel. As with the grid games, these exercises begin at a fairly simple level and increase in complexity as the student progresses.

One of the central concerns of the research is the effect of different degrees of student control on learning. Therefore, this material was

programmed in three ways, allowing the student total control, medium control, or no control over the order of presentation. Research is presently under way to assess the effects of this variable on learning, as well as the effectiveness of the material in general.

LEARNING STRATEGIES

As was discussed, we have used models and strong storylines to help students identify with problems and to motivate them to learn to use the solutions presented. In the case of the test anxiety instruction mentioned earlier, the interactive portion required the student to react in an "open-ended" manner by physically following directions or mentally rehearsing positive thoughts. But can modeling and storylines be used effectively when the "open-ended" student responses require writing diverse material in many different formats? How can these responses be judged? And then, how can feedback be presented to appear relevant to the individual? For these reasons, the most challenging subject area to deal with by means of interactive videodisc was learning strategies.

Learning strategies are the devices we all pick up over time to help us learn, remember, and recall information or physical skills. Those whose background did not adequately support the development of learning strategies are often at a disadvantage in academic settings. The identification of these strategies and interest in developing methods of teaching them is a relatively recent phenomenon. Therefore, a great deal of time was spent researching the literature to arrive at a unifying concept which would support approximately four hours of interactive instruction.

It was decided to center the instruction around the theme of "active learning"; to learn you must work with the material and put it in a form that you find best helps you understand and remember it. The literature refers to this technique as a "transformation process." Simple mnemonics, flow charts, and outlines of paragraphs or chapters are the types of learning strategies which are included in this framework. It was important to make the students realize that the correct way to "study" was to use these devices actively when preparing for tests or other performance exercises. This was the message the students were to hear throughout.

To motivate the students to complete the four hours of instruction, a single storyline was conceived that spanned the three learning strategies videodiscs. The story follows five junior enlisted soldiers in their preparation for the various testing phases involved in obtaining the prestigious Expert Infantryman Badge (EIB). The EIB can be said to represent the essence of soldiering. It requires an infantryman to obtain a perfect score on all of the hands-on components of his SQT, as well as performing at a high level on other physical and performance tests. This was especially important instructionally, since to teach learning strategies effectively it is necessary that relevant content be used so that students can see its value. The fact that only a small percentage of the soldiers who go out for the EIB actually achieve it is an added benefit for dramatic purposes.

Each of the three videodiscs is a complete story when viewed linearly, resembling a broadcast situation comedy. Scenes were shot at a variety of locations on two army bases, with military personnel as extras. Since students would interact with the instruction in one to two hour intervals, we

felt it necessary to complete one phase of the larger story at each sitting. In addition, each of the three segments contains a "running gag"; some aspect of the story which crops up repeatedly and is only resolved in the final scene of that particular segment. It was thought that the desire to see how the "gag" is resolved, along with the interest in the main storyline would provide adequate motivation for the student to work through all of the material.

The students follow the characters as they prepare for and discuss the various tests involved in the EIB. As they encounter problems, a friendly and respected First Sergeant suggests strategies to help them learn the material. After our students see the difficulties the characters are having and how they overcome them, they are asked to participate in exercises where they learn military content in a similar manner. To complete the exercises, a student must have a pencil and several pieces of blank paper. In most cases, he will see a demonstration of a learning strategy and how a character uses it. The student is then asked to perform a similar transformation. In some cases he does this "along with" one of the characters; at other times the exercises constitute a break in the story line. The video presentation pauses while the student works, displaying a still frame of relevant material. If it is not clear to the student what he should do, he has the option of seeing the instructions again. When he finishes each task in the exercise, an ideal example of the transformation is displayed and he is told to compare it to his and note any differences.

Throughout the first two discs the students are given a lot of guidance in applying the concepts being taught. The greater portion of the third disc is devoted to encouraging students to apply the techniques in a more independent fashion. This occurs in two stages. First, they see each of the

characters as they confront a situation in which they must learn particular information. This information is described and the student is asked to select the type of transformation which would be most appropriate. Feedback is presented in which all of the transformations which might be effective are described and shown.

When this first stage is completed, the characters are shown making last minute preparations and heading for the test site. The students are told that, as the characters take the last of their tests, they should try to apply the strategies they have learned. Sections from soldiers' manuals are then shown. In each case the student is asked to select the best transformation and then apply it. If an inappropriate technique is chosen, feedback is given which indicates that the student can use technique selected, but that there may be a better way. The best strategy is then described.

Once the correct technique has been selected/suggested, the student is given as much time as needed to carry it out. Finally, there is a quiz on the information. This quiz is constructed in such a way that if the student did, in fact, carry out the transformation he should be able to answer the questions correctly. It was hoped that this success would further convince the student of the value of active learning. If questions are answered incorrectly, the preferred transformation of the relevant information is shown and the student is told to look at it and find the correct answer. When the quiz has been completed, the final scene is shown and the student finds out which of the five characters received the EIB.

In this series of discs, the student must do a good deal more than make multiple choice selections. Writing outlines, sketching pictures and developing flow charts are just part of the activities designed to convince the

student that working with material can be an effective way to learn. The student judges his result by comparing it to a sample. Occasionally, he judges his results against a number of examples and then makes a multiple choice selection that triggers feedback keyed to the type of transformation he made. This type of interactivity requires that the exercises be carefully designed so that the student always feels he is capable of doing the tasks asked of him. This feeling of confidence is augmented by allowing the student total control over the pace of the interactivity and the ability to review instructions. This confidence should result in the student completing most, if not all of, the exercises. Even if the student decides to do little or no work, he will at least come in contact with all of the strategies by watching the disc for its entertainment value.

Two other features of the approach taken here should be noted. First, whenever appropriate an attempt was made to demystify the concept of learning. It was important to indicate to the student that learning can be a straight forward process when it is approached with the proper perspective. In addition, it was stressed that the strategies being recommended can be employed in a wide variety of situations, not just in the school/job context.

LESSONS LEARNED

It is our feeling that the future of interactive videodisc as an instructional medium is a bright one. Both video and computers have long been recognized as effective instructional tools. With the advent of the videodisc with all of its special capabilities, a merger of these two media became possible. The bringing together of the interactive features of the computer

and the visual and motivational aspects of video presents new opportunities as well as new challenges. We began this project with a good deal of experience in instructional television and computer-based instruction. Although this experience was invaluable to us, we discovered that a variety of considerations arise which are unique to interactive video or which simply take on new import with this medium. In closing we shall focus on the most important of these: the need for total integration of all phases of the design and development of the materials.

There are a series of steps which must be undertaken in the development of interactive video: from initial design to script writing, production, editing and programming. It would seem logical to assign the tasks associated with these different phases to people who have an expertise in each. The instructional designers come up with an approach to the content area. This is taken by writers who script it. Once the script is finalized it is given to production personnel who film and edit it. Once discs are mastered the programmer goes to work designing and implementing the interaction.

In theory this seems fine. In reality, however, the need for complete coordination between these phases is so great that segmenting them in this fashion is an invitation for trouble. During each phase of the design, those involved must be well aware of what is going to happen further down the line, as well as what has gone on before. Designers and scriptwriters must know what the system is capable of doing if they are going to use it to its maximum potential. They also must have an idea of what is practical in terms of time and money for production. Those involved in filming and editing need to have some acquaintance with the system and a clear idea of how the material will be

shown on-line. Finally, the programmers must be aware of the intentions of the designers vis-a-vis the interactive sequences.

Given this need for complete coordination between all phases of the project, we found it was most efficient to have a small team of people with overlapping skills involved in the development of any given piece. This group was made up of individuals with backgrounds in instructional design, script writing, television production and computer programming. They began working together at the beginning of the development process and remained involved through the completion of the piece.

This method of staffing had a number of positive outcomes. For instance, it meant that the interactive sequences were developed as part of the whole, rather than as an afterthought. In other words, a given piece was not thought of in terms of the "dramatic" portion and the interactive portion, but rather as an entire unit. This facilitated a real integration of the interaction with the instructional material.

The fact that script writers operated as part of the design team saved time which otherwise might have been spent outlining and clarifying the objectives and methods of the piece to a writer just coming into the process. The script writer was totally familiar with the objectives of a unit because he/she was involved in the derivation of them.

This was also true in production. Having the producer/director in on the development from the start made for an easy transition from paper to film, and a final product true to design goals. Finally, the programming was easily accomplished because everything had been laid out as part of the design process, a process in which the programmer took part.

The need for an integrated effort was even reflected in the evolution of script formats. At the outset of the project we created a special scripting form (Figure 7) to help writers maintain an awareness of the unique nature of writing for interactive videodisc. We fairly quickly found these forms to be unworkable. First, oversize paper made the forms difficult to copy. Second and more important, there was too little space for writing in some columns and wasted space in others. Initially there were shooting scripts, second audio track scripts and programming forms. As time went on the value of integrating these into one package became clear. The learning strategies scripts, for instance, are a complete package. They are designed in such a way that they are in fact shooting scripts, but they also contain all second audio track material and all of the computer graphics. In addition, all conditional links are specified. This format ensures that nothing is inadvertently left out during production. It allows the reader, during the review process, to form a much clearer picture of the flow of the material. And finally, it streamlines the programming process.

Coordination of staff efforts is obviously important in any large scale effort of this type. But we have found it to be particularly crucial in designing interactive videodisc training materials. Although other methods may well be effective, we found the staffing and scripting approaches described here helped greatly in guaranteeing an orderly development process and a well-integrated instructional package.

Work Group	Disc	Page	Unit	Sequence	Comments
CONTROL					
VIDEO					
AUDIO 1	Z				
AUDIO 2	ZITTA L				
MICROFICHE	Z				
OTHER MATERIALS	STATE				
COMMENTS					

Slides: _____
Role (Slide Show): _____

Seconds (Movies): _____
Skills (Slides): _____
Role (Slide Show): _____

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Figure 7: Special Scripting Form Found Unworkable

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APPENDIX

UNIT DESCRIPTION

APPROVAL

Name	Date
SDMS/IMS Control Structures (Underhill, Hargan)	_____
Production Feasibility (Production Coordinator)	_____
Military Content (Hannaman, Schulz, Freebie)	_____
Editorial Content (Wetherby, Galloway)	_____
Work Group Leader	_____
Sponsor	_____

Author: All

Date Started: May 8, 1981

Date Due: _____

Disc: DEMO

Work Group: DEMO

UNIT NAME: Angle Pool (for Demo Disc)

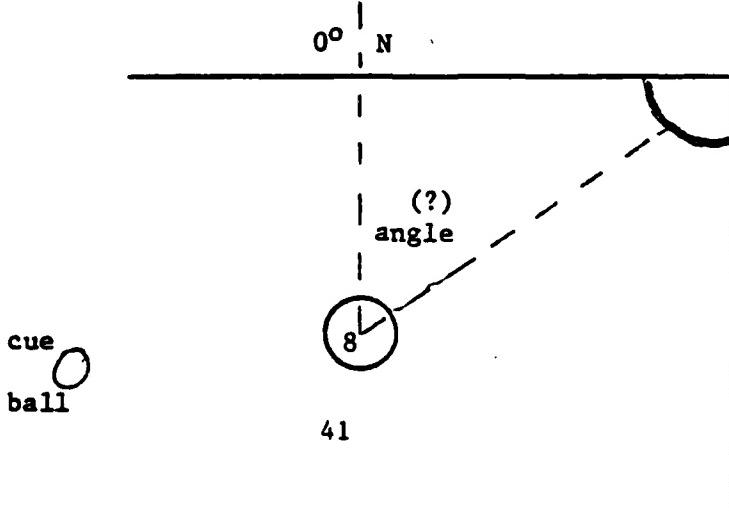
OBJECTIVE: To demonstrate how we will use an "entertainment (vs. functional) context," in this case a game to teach the baseline skill of estimating angles.

DESCRIPTION OF UNIT:

(Include overview of content, types of media to be used, SDMS/IMS control options available to the user and any other pertinent information needed to understand the nature of the proposed unit)

In this unit the student plays a game of "angle pool." The game is designed to help students learn to recognize (estimate the size of) the following angles: 0° , 15° , 30° , 45° , 60° , 90° , 135° , 180° .

The presentation of the angles corresponds to a compass with 0° to the north. The "angle" is formed as shown in Figure 1.



The student plays the game by selecting the angle measured from 0° N at which a specific ball would be hit into a designated pocket. The student "wins" the game after selecting the correct angle five successive times.

The game opens with a soldier entering a pool hall. A pool shark challenges the soldier to a game of Angle Pool. The shark, who never misses a shot, introduces the game and describes the rules. The shark then demonstrates how to play by calling 5 correct angles and, thus, sinking five balls in a row.

The student is then given a practice shot. If the student misses, he is branched to a second explanation (2nd audio track) of the angles and how to play the game.

The student then tries to call five angles in a row correctly, and does not exit normally from the game until he succeeds.

A problem "set up" (e.g., beginning with sequence 4, see flowchart) goes as follows:

4. The student sees an overhead view of the table, including an overlay of the specific angle. Student selects (from 3 choices) the size of the angle.
- 4a. If the student is correct, he sees the ball go into the pocket. If the student selects either of the two incorrect choices (4b and 4c), he sees the shot, which misses, at the chosen incorrect angle (angle labelled and overlaid on screen).
- 4d. The pool shark then hits the ball at the correct angle and it goes in the pocket. After an incorrect choice, the student is then branched to another series of five tries (again, see flowchart).

The following pages include:

1. FLOWCHART: Shows the flow of the game. Each sequence of the game is given a number. The script for each sequence is keyed according to these numbers.
2. SCRIPT
 - a) Introduction and Rules (sequences 1, 2, 3)
 - b) Problem setups, correct feedbacks and winning sequence (sequences 4-8, 4a-8a, 19)
 - c) Incorrect feedbacks (sequences 4b-8b, 4c-8c, 4d-8d)
 - d) Drawings of the problem "setups"
3. CONTROL SCREENS

SEQUENCE: 4

DESCRIPTION OF SEQUENCE:

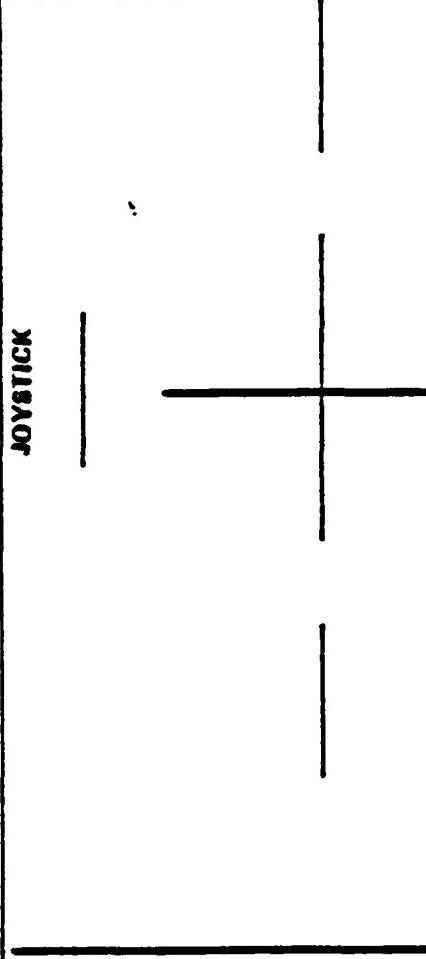
PROBLEM SET-UP FOR 90° .

- MOVIE
- SLIDES
- SLIDE SHOW

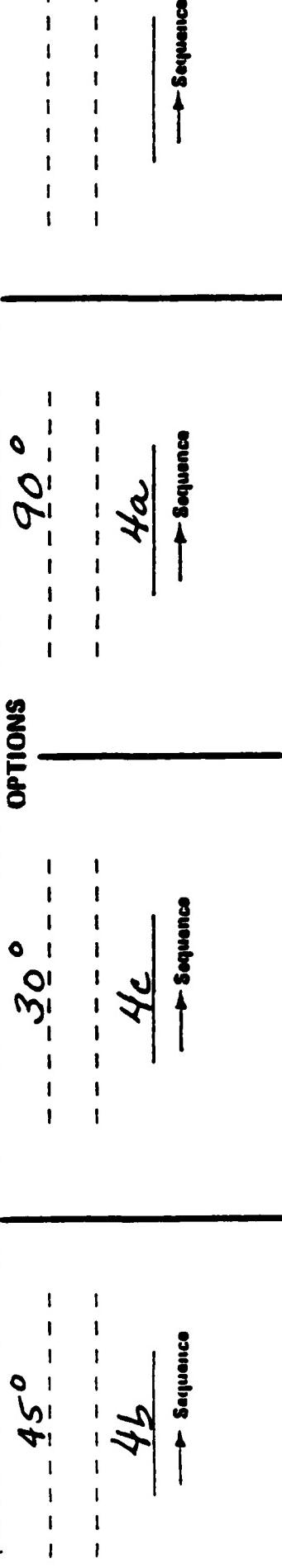
TEXT

CALL YOUR ANGLE.

JOYSTICK



$^{43} \underline{0}$ DOWN $\underline{5}$ TO 60



NOTES

SEQUENCE: 4a

DESCRIPTION OF SEQUENCE: CORRECT - BALL HITS POCKET AT 90°

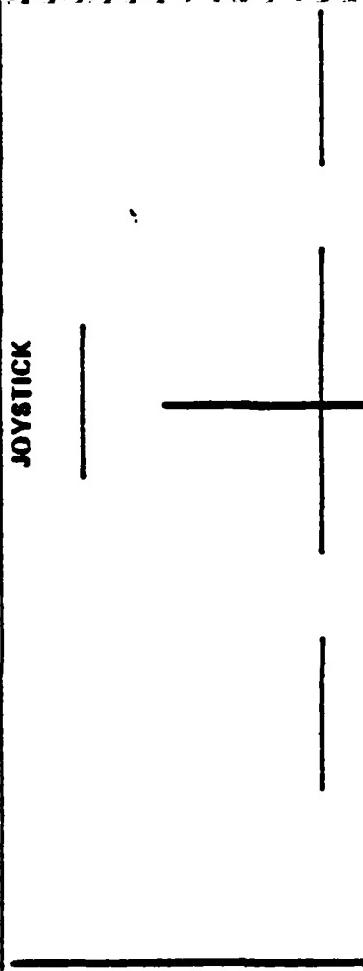
MOVIE
 SLIDES
 SLIDE SHOW

TEXT

You CALLED 90°.

* * * THAT'S IT. * * *

JOYSTICK



44 1 DOWN 4 TO 60

OPTIONS



→ Sequence

→ Sequence

→ Sequence

NOTES

default link to seq. 5

<input checked="" type="checkbox"/> MOVIE <input type="checkbox"/> SLIDES <input type="checkbox"/> SLIDE SHOW	
SEQUENCE:	46
DESCRIPTION OF SEQUENCE: Miss - 45°	
TEXT	You CALLED 45°.
JOYSTICK	
OPTIONS	
NOTES <i>default link to 4d</i>	

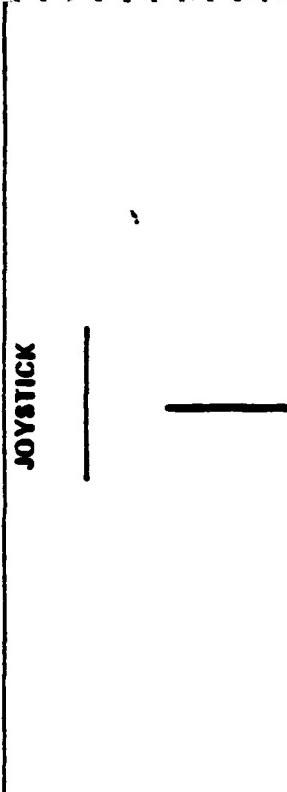
SEQUENCE: *4c*

DESCRIPTION OF SEQUENCE: *MISS - 30°*

TEXT

You CALLED 30°.

JOYSTICK



MOVIE
SLIDES
SLIDE SHOW

OPTIONS



NOTES

Default Link to 4d

SEQUENCE: *4d*

MOVIE
 SLIDES
 SLIDE SHOW

DESCRIPTION OF SEQUENCE: *Pool Share Hits 90°*

TEXT

JOYSTICK

OPTIONS

→ Sequence

→ Sequence

→ Sequence

→ Sequence

NOTES

default limit to seg. 9